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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
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1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED	Final Report, 1 May 89 thru 31 Dec 89
4. TITLE AND SUBTITLE		FREE BOUNDARY PROBLEMS FOR FLOWS WITH VORTICITY	
6. AUTHOR(S)		Alan R. Elcrat	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)		Wichita State University Department of Mathematics and Statistics Wichita, KS 67208-1595	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		AFOSR-NM Building 410 Bolling AFB, DC 20332-6448	
11. SUPPLEMENTARY NOTES		<p>DTIC S ELECTED FEB 27 1990 CD D</p>	
12a. DISTRIBUTION/AVAILABILITY STATEMENT		Approved for public release; distribution unlimited.	
12b. DISTRIBUTION CODE			
13. ABSTRACT (Maximum 200 words)			
<p>The research supported by this grant centered on the study of inviscid flows with concentrated regions of vorticity. There were related studies of numerical conformal mapping and construction; of minimal surfaces.</p>			
14. SUBJECT TERMS		15. NUMBER OF PAGES 2	
16. PRICE CODE			
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT SAR

NSN 7540-01-280-3300

Standard Form 290 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18

FINAL TECHNICAL REPORT
89-0323
AFOSR GRANT 86-0274

PRINCIPAL INVESTIGATOR: Alan R. Elcrat

The research supported by this grant centered on the study of inviscid flows with concentrated regions of vorticity. There were related studies of numerical conformal mapping and construction of minimal surfaces.

In the paper [1] published during the completed support period the flows past a class of three dimensional bodies was studied using matched asymptotic expansions. The near field was computed using a wake theory developed earlier in [2], and the far field was obtained from a superposition of a distribution of vorticity and sources on a line segment. In another paper [3] a class of flows with constant vorticity regions were computed from a variational principle which had been used earlier in theoretical work [4] for such flows. Other published work supported by this grant was [5] in which scattering of electromagnetic waves from a dielectric slab with time varying permittivity was studied, and [6], in which the Gauss Map was used to construct a new class of minimal surfaces which become vertical on a part of the bounding curve.

During the year a comprehensive set of computations was done to compare several methods for the conformal mapping of the exterior of a disk to the exterior of bounded region. The methods tested were the classical Theodorsen method, the method of Wegmann, and the methods of Friberg and Timman. These results are potentially useful for aerodynamics for transplantation of flows and for grid generation. A paper was submitted to the SIAM Journal of Scientific and Statistical Computing and was accepted, Fall 1989. Work is in progress to extend the Timman method to domains with corners; preliminary computations are promising, and a detailed report should follow during the next period. Also, this method applies naturally to Helmholtz-Kirchoff flows, and other wake models, such as that used in [1], and work is in progress to make this work computationally.

In another computational work based on a variational principle, a Prandtl-Bachelor flow, in which a constant vorticity region is bounded by a vortex sheet, was computed. The geometry was a Riabouchinsky type configuration in which an arc and its image in a reflection plane are joined by a symmetric arc which carries a vortex sheet. The procedure was based on minimizing a functional in which the main terms were Dirichlet integrals representing virtual mass and vortex energy. These were computed using conformal mapping to the unit disk and Fourier series. Work is in progress on extending these ideas to domains with cusps such as those which occur in the wake behind an obstacle. There are difficulties connected with "thinness" of such domains near the

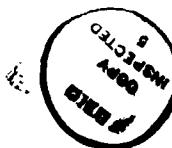
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cusps which require significant modifications to the work completed.

Finally, an extension of earlier theoretical work [4] on existence of steady vortex patches was made. In this work the class of vorticity functions used was the set of rearrangements of a fixed function. Work is in progress on developing a computational algorithm for obtaining the "profile function" which relates the vorticity to the stream function in the resulting flow.

References

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